Building Research Establishment Digest

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Waste of building materials

Waste on construction sites is considerable: the overall loss of principal materials is about 100 per cent more than is usually allowed for in estimating and technical accounting conventions. This figure is, of course, highly variable and is much lower on some sites. Waste occurs at all stages of materials handling on site; when they arrive, when they are stacked, when they are moved and when they are fixed or placed.

Some waste will always occur in construction because of the nature of the operations but much can be done to reduce the problem. There is a need for better communication between those who design and those who construct, and for more attention to be paid to materials control. The greatest change required, though, is one of attitude.

Prepared at Building Research Station, Garston, Watford, WD2 7JR
Technical enquiries arising from this Digest should be directed to Building Research Advisory Service at the above address.

It is generally recognised that not all the materials delivered to construction sites are used for the purposes for which they were ordered and that builders frequently use more materials than they receive payment for; either they are lost or they are used in the buildings in ways which are not recognised by estimators and technical accountants. Although these differences have never been clearly defined, they are known as 'waste'. Whilst it is on the site this waste occurs, it is not always the result of action there; designers of materials and structures, quantity surveyors and so on, can all be responsible for losses over which the builder has little control. Actions on site can, however, exacerbate these losses.

Waste occurs in many forms but can be categorised into two main types:

Direct waste The complete loss of materials such as when they are irreparably damaged or just lost from the site. Whilst direct loss can occur at every stage of materials handling, the principal loss centres are where materials are stacked and at the place of work.

Indirect waste Where materials are used either for purposes other than those specified (eg facing bricks in internal plastered block walls) or in excess of measured quantities to meet the dictates of production. It is distinguishable from direct waste because usually the materials are not physically lost. There is , however, a monetary loss and failure to recognise and record indirect waste makes materials accounting meaningless.

Until recently the incidence and magnitude of losses was not generally known because of the insensitivity of methods of accounting for materials. These normally offer little more than a very broad check that deliveries match invoices. But studies at BRE have shown that the amount of direct waste is not only considerable but also highly variable and that a real opportunity for worthwhile reductions does exist.

Two studies have been completed. The first was designed to find the incidence and nature of the losses, the second to devise and test an accounting system to enable waste to be monitored while works are in progress as part of the builder's management system.

Because of the number and range of variables, it has been impractical for BRE to include all forms of construction and materials in their studies. Investigations have concentrated on direct waste for ready-mixed concrete, walling materials, timber and plumbing goods. The studies have been principally of traditional construction and, because of the importance of housing in the building market, about 70 per cent of the sites have been for housing projects. The remaining sites covered a variety of building types in both the public and private sectors. The works ranged in value from about £50,000 to over £1m, with the majority of the contracts between £100,000 and £400,000.

As part of the studies, direct observations were made on the effects of materials handling and fixing; waste counts were made during progress of the site work and, on a more general level, contractor's records of delivery were compared with measurements of finished work.

The results of these studies are summarised in Fig 1 which shows the total direct waste for each site as a percentage of the aggregated deliveries together with the normal allowance used in the UK for waste of the material. Similar 'norms' for waste are used in a number of other countries.

How waste occurs

All those involved in a building project contribute to waste: designers, materials suppliers, site managers, site operatives and so on.

The building design rarely takes account of the size of materials to be supplied. One of the most frequent forms of loss is due to cutting: bricks to bond, timber to lengths or sheeted materials to regular shape. Incomplete detailed design at the beginning of the contract or documentation which does not match design intentions, or is unclear, encourage waste because materials cannot be scheduled accurately, deliveries cannot be linked to a work programme and site storage cannot be planned. During construction, variations in design can lead to waste.

The present measuring conventions, represented by traditional bills of quantities, are geared to financial control of the contract rather than to production and materials control. Unless scheduling and special measurement is duplicated, therefore, no control is exercised over materials.

Little is done to ensure that materials are produced, packaged and delivered to site in suitable sizes and forms and so losses occur on site from the moment the materials arrive. Standardised loads and packages would make it easier to check goods on arrival and checking would be easier to organise if suppliers delivered at a specified time. The employment of a skilled checker by the builder would make the process more efficient on all but the smaller sites (where this function must be undertaken by the foreman).

Waste results from all building operations but particularly from bad stacking at and near the work place. During movement around the site, damage is caused by drivers cutting corners and running over materials; less waste was observed on sites where roads had been laid first. Waste occurs during fixing and placing operations when materials are dropped, spoiled or discarded. Labourers not knowing the needs of craftsmen leads to a surplus of materials at the work place and overmixing can mean that concrete, mortar and plaster is left to harden at the end of the day. Succeeding trades can cause waste by damaging completed work.

A significant amount of materials can be lost or damaged by theft or vandalism, often because of insufficient security precautions.

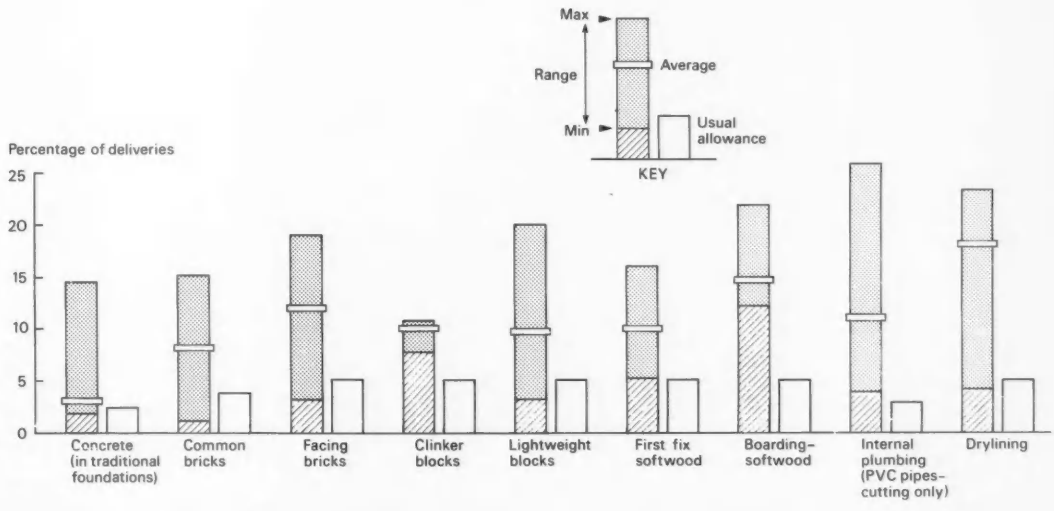
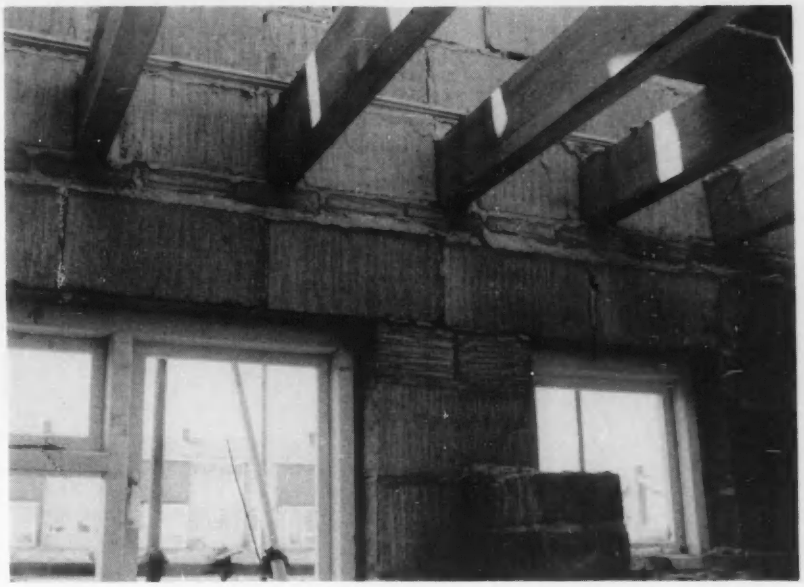


Fig 1 Principal results of direct waste from BRE studies on 230 sites

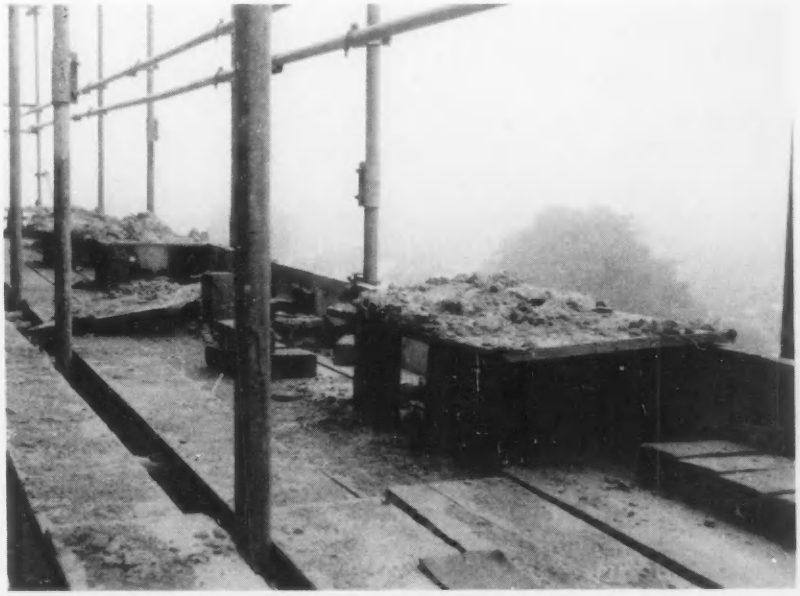
"Waste results from all building operations but particularly from bad stacking.....

.....damage is caused by drivers cutting corners and running over materials....."



".....take account of standard sizes of materials to avoid unnecessary cutting on site....."

".....overmixing can mean that concrete, mortar and plaster is left to harden at the end of the day".



Tackling the problem

Waste is everyone's concern, and everyone can contribute to its reduction. The rules are clear and simple.

The Architect should: take account of standard sizes of materials to avoid unnecessary cutting on site;

in pre-contract documentation, specify work in precise and practical terms so that estimators can predict likely waste;

state clearly the materials to be used, and acceptable alternatives to facilitate ordering.

The Manufacturer and Supplier should: design components and materials to be durable, easily handled and suitably packaged for safe transport to and on the site;

supply components and materials to the standards, sizes and tolerances preferred by the industry;

arrange deliveries at specified, agreed times.

The Independent Quantity Surveyor should: ensure that the specifications in the tendering documents match the standards of work required and the format used clearly communicates likely waste levels arising from the design.

The Estimator should: record waste levels used in unit rates so that analagous rates can be negotiated amicably if an issue arises during the settlement of variations.

The Managing Director should: ensure that those involved in materials control are trained and motivated;

delegate the necessary responsibility and authority;

establish procedures within the firm to ensure effective handling of materials and recording of waste levels.

The Buyer should: specify precisely the quality and quantity of materials, the timing and method of delivery and the method of packaging.

The Site Manager should: plan in advance adequate storage space in the correct position to ensure security, safety and protection;

carry out procedures and delegate responsibility for reception of materials including checking quantity, inspection and documentation;

provide adequate handling resources to take account of the means of access, and co-ordinate and plan their use;

lay down procedures for on-site issue of materials and reception by fixers including the necessary transport handling and recovery of unused materials (and the return of packages);

initiate feed-back to buyer if delivered materials do not meet standard required and to quantity surveyor if design waste is not explicit in tendering document;

lay down adequate instructions for fixers and handlers for the best current practice and have a control system so that when avoidable waste levels are identified, action can be taken.

The Site Operative should: use care in handling and transporting materials;

not use materials for purposes other than intended - it can cause waste and also result in poor performance (sound or thermal insulation for example);

not leave materials laying around the site - an untidy site not only causes waste but is dangerous.

Table 1 Direct and indirect waste

Direct waste

Transport and delivery waste

This covers all damage caused during loading and losses in transit to the site (and from the site in the case of transfers from one contractor's site to another) unloading and placing into the initial storage.

Site storage and internal site transit waste

This waste arises from bad stacking and the initial storage, transporting around the site to stack at the work place or placing into position. (Poor stacking accounts for considerable losses and storage for other losses in goods like cement and plaster which must be kept under dry conditions. The transit around the site from the initial stores to work place often means damage during the loading, movement and unloading. Much damage has been noted because drivers on site goods damage as they 'cut corners' and this leads to differences in waste between sites which lay their roads first and those who work in 'natural conditions').

Conversion waste

Losses due to cutting uneconomical shapes, eg timber.

Excess materials at the work place

Overmixing because labourers do not know needs of craftsmen.

Fixing waste

Materials dropped, spoiled or discarded during the fixing operation.

Cutting waste

Losses caused by, for example, cutting timber to length, bricks to bond and sheeted material to irregular shapes. (Frequently the design of the building takes little account of the size of the materials. Dimensional co-ordination is not being applied yet to an effective scale in practice. This means, particularly in the case of sheeting, that extra cutting waste occurs often solely due to the lack of thought by the designer to the size of the material).

Application and residue waste

Materials such as mortar for brickwork, plaster and paint being spilled or dropped because of their nature. Similarly paint left in cans which are not resealed. Mixed mortar and plaster left to harden at the end of a working day.

Waste caused by other trades

This varies from borrowing by trades (for purposes other than the works, and not returning the plant or replacing the material) to damage by succeeding trades.

Criminal waste

This covers pilfering, theft from sites and vandalism.

Waste due to the wrong use

When the wrong type or quality of materials are used, waste may arise. (The material may be too good a quality and the contractor bears the loss. If the quality is low, the client will lose and defects may arise later. There is a risk that an alert architect or clerk of works may require that is replaced by the specified material under the contract).

Waste stemming from materials wrongly specified

Waste due to specification errors in the bills of quantities, eg referring to outdated documents. (Variation orders compensate the contractor but the client has to bear the financial loss).

Learning waste

Usually by apprentices and tradesmen on new operations.

Waste due to the uneconomic use of plant

This covers plant left running when not in use, and plant not employed to its optimum use.

Management waste

Stems from lack of materials control, wrong decision making or indecision, and is not related to anything other than poor organisation or lack of supervision. (A failure to decide and work out a plan for the storage of material often results in unnecessary double handling and therefore falls under this heading).

Indirect waste

Substitution

While substitution is not a form of waste causing direct losses, it causes a monetary loss, because the materials are used for a different purpose from that specified.

Substitution arises due to three reasons:

(i) Because too much material is brought to the work place, eg facing bricks used in building the outer skin are left and subsequently used in building the internal walls. Likewise common bricks from the inner skin are left behind for internal partiions.

(ii) Because damaged materials, eg facing bricks can be used in a position as a functional building unit, such as an internal skin for block walls; plaster will cover the damage.

(iii) Because it is increasingly the practice of building construction to use certain materials, eg bricks to make up dimensions in the case of blocks walls, and this is a more effective method to form a bearing for the floor above and usually cheaper practice than cutting the blocks by machine.

Production waste

Some material is used for which the contractor does not receive any payment because the basis of measuring conventions does not allow accounting related to the size of the plant, eg excavation, and remains insensitive to tactical problems such as placing materials. Other material used is not subject to detailed accounting, such as concrete in tower crane bases.

Negligent waste

Often the contractor uses more material than specified, eg due to over-digging in the case of concrete foundations or poor workmanship.

Every project should have waste recorded as part of the costing procedures. A simple method of accounting for the materials used on site and for assessing the level of waste is described in BRE Current Paper CP 4/78.

Control of waste on site involves a number of people and a number of small actions and decisions. In essence, a change of attitude throughout the industry is required. Because one decisive action cannot be identified, the situation will not be improved overnight but improvement is possible and does not require high technology or complex organisational changes. Any decision must be balanced between the savings to be achieved and the cost of achieving them, but substantial savings are clearly possible and the problem must be frequently and clearly brought to the attention of all personnel: posters can help with this. The loss of materials means a reduction in company profits and efficiency and therefore possibly a loss of staff bonuses. Untidy sites are also unsafe sites.

Further reading

SKOYLES, E. R. Site accounting for waste of materials. BRE Current Paper CP 5/78.

SKOYLES, E. R. Waste of materials and the contractor's quantity surveyor. *Quantity Surveyor,* 1976, **32,** June.

SKOYLES, E. R. Waste of materials - a problem on building sites. *West African materials and equipment,* January 1979.

Try reducing waste. IOB Site control guide. 1979.
Materials control and waste in building. 1980.
Both available from Chartered Institute of Building, Englemere, Kings Ride, Ascot, Berks, SL5 8BJ £1 memebers, £1.25 non-members.

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Films

Design waste of building materials (Ref UK 2813)
Site waste of building materials (Ref UK 2868)
Both available on loan from: Central Film Library, Government Buildings, Bromyard Avenue, Acton, W3 7JB (Tel: 01 743 5555)

Posters

A set of four posters, produced by NFBTE in collaboration with BRE, is available from NFBTE Publications, 82 New Cavendish Street, London W1M 8AD

Department of the Environment **Building Research Establishment**

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